

## DEVICE FOR INSPECTING AND ROTATING ELECTRONIC COMPONENTS

**[0001]** This application is the National Stage Application of International Application No. PCT/EP2005/050388, which was filed on January 31, 2005, and which claims priority to German Patent Application No. 10 2004 007 703.7, which was filed on February 16, 2004, and which are incorporated herein by reference.

### BACKGROUND OF THE INVENTION

**[0002]** Field of the Invention

**[0003]** The invention relates to a device and a method for checking and rotating electronic components, in particular flip chips, with a pivoting part attached to a pivotal point for rotating the electronic components, a first pickup element being fixed on the exterior of the part for picking up a single electronic component from a substrate and keeping hold of it during a rotational movement of the part.

**[0004]** Description of the Background Art

**[0005]** For methods that are based on a flip chip principle, it is known that individual electronic component parts arranged in a sandwich separated from one another, such as semiconductor chips arranged in a wafer, the wafer in turn being set on an extensible carrier sheet, are picked up from this carrier sheet and rotated, i.e. turned upside down, in order to deposit them in the rotated position for the subsequent die bond or die sort. For this purpose, a single chip is first detached from the reverse side of the carrier sheet with a needle, a so-called die ejector, and transferred with a pickup element, such as a vacuum pipette, advanced from the front or from above. For this, the vacuum pipette is usually arranged as a flip tool on a flip head of a part pivoting about a pivotal point, and keeps hold of the selected chip during a 180° rotation of the pivoting part. After the 180° rotation has taken place, the chip turned round in this way is picked up by a pick-and-place element on its reverse side, in order then to transport the chip in this rotated situation to the desired position, for example within a smart card module.

**[0006]** In order to check the surface of the individual chip still arranged on the substrate for intactness before it is picked up, and at the same time to be able to check

that it is in the correct position before it is picked up, a first optical facility, for example a camera, is arranged above the pivoting part for the inspection of the wafer. Since an optical connection line set up perpendicular to the surface of the wafer and the chip between the first optical facility and the wafer surface is important for an optimized check, the camera is arranged directly over the chip to be picked up. For this reason, the pivoting part must be rotated out of the perpendicularly running optical connection line each time before a chip is picked up, in order that a so-called wafer inspection can be performed.

**[0007]** This results in the following sequentially occurring method sequence for each flip chip: First, a check of the surface of the chip to be picked up must be performed using the camera. The flip head is then rotated into the optical connection line, in order to pick up the chip by its upper surface using the vacuum pipette attached to the flip head. By means of the pivoting part, whose rotational axis is arranged outside the optical connection line, the chip is now rotated through 180° in such a way that the flip head is now in a rotated position outside the optical connection line. A further check performed on the chip's position by means of a second optical facility in the form of a camera should supply data on a flip offset of the flipped chip. The flipped or rotated chip is then transferred to a placing facility in the form of a place head, and a correction is made to the flip offset based on transferred correction values.

**[0008]** Such a sequence of successive steps leads to a high time requirement for the overall process of checking and rotating a chip, and thereby reduces the throughput of the device. It therefore also results in higher operating costs.

## SUMMARY OF THE INVENTION

**[0009]** It is therefore an object of the present invention to provide a device and a method for checking and rotating electronic component parts, in particular flip chips, with a pivoting part for rotating the components, the device and the method being time- and cost-saving.

**[0010]** An object of the invention is that in a device for checking and rotating electronic components, such as flip chips, with a pivoting part attached to a pivotal point for rotating the electronic components, on the exterior of which part a first pickup

element is fixed for taking up a single component from a substrate and keeping hold of it during a rotational movement, a second pickup element is arranged externally on the part opposite the first pickup element in relation to the pivotal point in such a way that in each case one pickup element is facing the substrate for each rotation of the part through  $180^\circ$ . The part further has a through opening between the pickup elements such that the through opening is facing the substrate for a rotation of the pivoting part through  $90^\circ$  or  $270^\circ$ . In this way, during a  $180^\circ$  rotation of the pivoting part, first the chip can be picked up from the substrate by the first pickup element, developed for example as a vacuum pipette, after a rotation through the first  $90^\circ$  an optical connection line between a first optical facility arranged above the pivoting part for checking the surface and the correct position of a further chip arranged on the substrate based on the vertically aligned through opening, and a depositing of the chip on a placing facility likewise arranged relocatably above the pivoting part can take place, the chip meanwhile turned round after an executed  $180^\circ$  rotation. At the same time, by means of the second pickup element which can likewise be developed as a vacuum pipette, the further component is picked up from the substrate, since the second pickup element is now arranged over the wafer surface. A subsequent  $180^\circ$  rotation in the reverse direction of the pivoting part results in a further execution of the process described above.

**[0011]** Since a wafer inspection, a pickup and a deposit of the chip can occur within a single  $180^\circ$  rotation of the pivoting part developed according to the invention, as well as the turning round of the chip and also the picking up of a further chip, a considerable saving of time is hereby achieved. This considerably increases the throughput of the device as a whole, thereby reducing the operating costs of the device.

**[0012]** According to a preferred embodiment, the first pickup element is fixed to a first projection of the part, and the second pickup element to a second projection. The through opening can then be provided between the projections as a through channel open on one of its long sides. Thus, not only can the vacuum pipettes be fixed optimally to the pivoting part, but a simple manufacture of the through channel by a milling process is also possible, thus enabling economical manufacture. In addition, such a design of the pivoting part means that a rotational axis extending perpendicular to the

course of the through channel is arranged not blocking the view for the first optical facility within the through channel.

**[0013]** A second optical facility is preferably arranged in the form of a camera for checking a correct position of the previously rotated and possibly deposited chip, in order that a flip offset can be determined and correction data can accordingly be passed to the placing facility for correcting the chip's position.

**[0014]** The first optical facility is activated with a predefinable time delay after a rotation or swivel of the through opening into the optical connection line between the first optical facility and the chip to be checked, arranged on the substrate. By this means, partially blurred images caused by the projections rotating with the part can reliably be avoided.

**[0015]** Further scope of applicability of the present invention will become apparent from the detailed description given hereinafter. However, it should be understood that the detailed description and specific examples, while indicating preferred embodiments of the invention, are given by way of illustration only, since various changes and modifications within the spirit and scope of the invention will become apparent to those skilled in the art from this detailed description.

#### BRIEF DESCRIPTION OF THE DRAWINGS

**[0016]** The present invention will become more fully understood from the detailed description given hereinbelow and the accompanying drawings which are given by way of illustration only, and thus, are not limitive of the present invention, and wherein:

**[0017]** FIG. 1 in a schematic front view, a device for checking and rotating semiconductor chips according to prior art;

**[0018]** FIG. 2 in a schematic front view, a device for checking and rotating semiconductor chips according to an embodiment of the present invention;

**[0019]** Fig. 3 is also a schematic front view of the device of Fig. 2, with the pivoting part rotated 90 degrees.

**[0020]** Fig. 4 is a schematic side view taken along line 4-4 of Fig. 3.

**[0021]** Fig. 5 is the schematic view of Fig. 4 with the pivoting part rotated 90 degrees.

**[0022]** FIG. 6 in a perspective view a pivoting part for the device for checking and rotating semiconductor chips according to an embodiment of the invention;

**[0023]** FIG. 7 in a schematic side view the pivoting part shown in FIG. 6;

**[0024]** FIG. 8 in a schematic front view a representation of the principle of the method according to the invention; and

**[0025]** FIG. 9 in a schematic representation, checking areas for a through opening rotated to the left and to the right within the pivoting part.

#### DETAILED DESCRIPTION

**[0026]** As can be seen from FIG. 1 in a schematic front view, previously according to prior art a pivoting part 3 was used for detaching individual semiconductor chips, not shown here, from a wafer or from its substrate 1 by means of a die ejector 2, this part 3 enabling, by the design of a rotational axis projecting into the drawing plane to form a pivotal point 4 at the left-hand end of the part, a swivelling in and out of a flip head 5 with arranged on it a pickup element 6, out of an optical connection line between a first optical facility 7 and the wafer surface. The solid lines of the flip head represent a pickup or pick position of the chip to be picked up, while the dotted lines of flip head 5 reflect a deposit or place position on a placing facility 8 following the pickup process. The placing facility 8 likewise has a pickup element 9, for example in the form of a vacuum pipette, in order to place the now turned chip within a smart card module, for example, by moving the placing facility 8.

**[0027]** A pivoting part of this nature has only one pickup element, for one thing, and for another requires the time-consuming sequential method sequence that has already been described.

**[0028]** In FIG. 2, a device for checking and rotating semiconductor chips according to an embodiment of the present invention is shown in a schematic front view. It can be seen in this representation that above a wafer and an associated substrate 11 with a wafer surface 11a, from which individual semiconductor chips are ejected with a die ejector 12 from below upwards, a pivoting part 14 is arranged in such a way that it rotates in an executed rotation as indicated by arrows 15, 16 about a pivotal point 17,

which is arranged above the chip to be picked up. The wafer can be moved with the substrate 11 in the x or y direction, as is indicated by the double arrow 13.

**[0029]** On cheek projections 18a and 18b the pivoting part 14 has two opposite pickup elements 19, 20—for example in the form of vacuum pipettes—, which enable simultaneous picking up and depositing of two semiconductor chips. The first vacuum pipette 19 can pick up a semiconductor chip from the substrate 11, while the second vacuum pipette 20 deposits a further semiconductor chip on a placing facility 21, which can for example be equipped with a further vacuum pipette 22. The placing facility 21 is then moved sideways as indicated by the double arrow 24.

**[0030]** At almost the same time the pivoting part 14 rotates about its pivotal point 17—this time in the opposite direction to the preceding rotation—, and after a 90° rotation a through opening not shown here arranged in the pivoting part 14 generates a sight channel 23a from a first optical facility 23 running vertically through the part 14 to the surface 11a of the substrate 11 covered with the wafer to a further semiconductor chip.

**[0031]** This sight channel is used for carrying out a short-time recording by the first optical facility 23 developed as a camera, of the further semiconductor chip to be picked up in the future on the substrate 11, for checking of the surface and the correct position.

**[0032]** As soon as the pivoting part 14 has finished its 180° rotation after a further 90°, the pickup of the further semiconductor chip is executed by the second vacuum pipette 20.

**[0033]** A second optical facility in the form of a die on the fly camera 25 is arranged for checking a flip offset of the previously rotated chip. In the event that there is a flip offset, this facility calculates corresponding correction data and passes this to the self-adjusting place element 21. The place element 21 then deposits the chip in an indexer 26, its position being checked by a further camera 27.

**[0034]** Fig. 3 shows the device of Fig. 2, where the pivoting part 14 is rotated 90 degrees. At this point, the placing facility 21 is moved (with a semiconductor chip) to a position over the indexer 26 and out of the optical path 23a. The optical path 23a is now unobstructed as it passes between the projections 18a, 18b of the pivoting part 14 to the surface of the substrate 11a.

**[0035]** Fig. 4 is a side view of the device shown in Fig. 3. The pivoting part 14 is shown connected to the axis of the pivoting point 17 which is driven by motor 40 to rotate the pivoting part 14. It can be seen in Fig. 4 that the optical path 23a passes in front of the pivoting part 14 between the projections 18a, 18b so that the camera may view the surface of the substrate 11a.

**[0036]** Fig. 5 is the same view as in Fig. 4, except that the pivoting part 14 is rotated another 90 degrees. At the same time, placing facility 21 is returned to a position to pick up a semiconductor chip from the pickup element 19, thereby again blocking the optical path 23a.

**[0037]** FIG. 6 shows in a perspective view a possible embodiment of a pivoting part 14 for its arrangement in a device according to the invention for checking and rotating electronic components. As can be seen from the representation, the pivoting part is equipped at its pivotal point 17 with a hole to accommodate a rotational axis, not shown here, around which the pivoting part 14 rotates.

**[0038]** The projections 18a and 18b developed as cheeks are used to accommodate and attach pickup elements, not shown here, which can be developed as vacuum pipettes, for example.

**[0039]** The through opening 28 is developed in this case as a through channel open on one long side, and milled into the part in a simple manner.

**[0040]** As can be seen from a side view of the pivoting part in FIG. 7, during its rotation around a rotational axis arranged in a drilled hole 29 the part 14 permits a maximum inspection window of a distance between the projections 18a and 18b. This distance can have a dimension of about 20 mm, for example. In a further rotation beyond the 90° setting of the pivoting part 14, the inspection window then shrinks again, and vanishes entirely at a 180° setting of the pivoting part 14.

**[0041]** FIG. 8 shows in a simple schematic front view the functioning of the device according to the invention. The pivoting part, not shown here in detail, which is arranged between the camera 23 and the substrate 11, contains among other features the through opening 28, which moves in a circuit 15a.

**[0042]** As soon as the through opening 28 is in a vertical position, meaning that the pickup elements not shown here are aligned horizontally, the optical connection line

23a can be set up from the camera 23 to the semiconductor chip to be removed on the substrate 11. Within this brief swivelling in of the through opening 28 into the optical connection line 23a, a short-time recording takes place of the surface and the position of the semiconductor chip to be removed. A further rotation of the part in a counter-clockwise direction, as indicated by the arrow 15, allows the pickup element not shown here to sweep to the chip to be removed and pick it up. A 180° rotation of the part then takes place in the opposite direction, i.e. clockwise as indicated by the arrow 16. Alternatively, the pivoting part may complete a 360° rotation rather than reciprocating.

**[0043]** In FIG. 9 there is a schematic representation of the observation/inspection areas that are available to the camera 23 during a rotation of the part 14 developed with the through opening 28. For a total 360° rotation of the part and the through opening counter-clockwise (reference label 31) and clockwise (reference label 32), as also indicated by arrows 33 and 34, available inspection areas 35 and 36 are formed at an approximate 90° setting of the part.

**[0044]** In order not to cause any blurred images in swivelling the through opening into the optical connection line between the camera and the wafer, the camera is activated with a time delay of about 10 msec, as represented by the angle sections 37 and 38.

**[0045]** All features disclosed in the application documents are claimed as essential for the invention, provided they are novel individually or in combination in the light of the prior art. All features disclosed in the application documents are regarded individually or in combination as essential for the invention. Variations of these are familiar to the person skilled in the art.

**[0046]** What is claimed is: